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UC-41 - Health and Safety

APPLIED HEALTH PHYSICS

ANNUAL REPORT FOR 1959

OAK RIDGE NATIONAL LABORATORY

operated by

UNION CARBIDE CORPORATION

for the

U.S. ATOMIC ENERGY COMMISSION

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HEALTH PHYSICS DIVISION

APPLIED HEALTH PHYSICS ANNUAL REPORT FOR 1959

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OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee
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UNION CARBIDE CORPORATION
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U. S. ATOMIC ENERGY COMMISSION

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I. SUMMARY

Present indications are that no individual received an exposure in excess of permissible values during 1959. Although there were noticeable rises in background levels at certain of the monitoring stations located at and near the Laboratory premises, the general situation as related to environmental contamination was not significantly different from that experienced in previous years. These observations are particularly important in that three separate contamination incidents occurred during the months of October and November which resulted in extensive short-term contamination of the Laboratory premises.

A. Area Monitoring

The average air contamination levels shown by the continuous air monitors for the Laboratory, perimeter, and remote areas were 0.4%, 1.6%, and 1.4% respectively of the maximum permissible concentration[1]. Air contamination levels during the first half of 1959 in the perimeter and remote areas were more than a factor of 10 greater than levels experienced during the last half of the year. Specific analyses for fission products and decay studies indicated that the higher levels experienced during the first part of the year were due to fall-out attributable to world-wide weapons testing. Stations HP-23 and HP-24 were in operation only during the latter half of 1959 and do not reflect the higher levels of contamination experienced at other stations during the first half of the year. The peak value for air contamination on the Laboratory area which occurred during Week 44 probably resulted from a malfunctioning Cottrell precipitator.

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1. The $(MPC)_a$ for occupational exposure is taken to be 1×10^{-9} μc/cc; the $(MPC)_a$ for the neighborhood population is taken to be 1/10 of the occupational exposure. (See NBS Handbook 69, Table 4, p. 94.)

Fall-out data and rain water data generally follow the same trend as the continuous air monitoring data.

The probable average concentration of mixed fission products in the Clinch River at Mile 20.8 (the point of entry of the wastes into the river) and at Mile 4.5 (near Kingston, Tennessee) were 3.1×10^{-7} μc/cc and 4.9×10^{-8} μc/cc respectively. These values are 25.4% and 22.3% of the weighted average maximum permissible concentration for the mixture of radioisotopes for populations in the neighborhood of a controlled area[2]. Although the NCRP and ICRP suggest that the average annual concentration of radionuclides in water should be used as a criterion of acceptable radioactive waste disposal practice, it is worthy of note that the $(MPC)_w$ value was exceeded three weeks during the year. The first two instances resulted from heavy rains which scoured a large amount of radioactive silt from the White Oak Creek drainage basin. The third instance resulted from loss of dilution in the Clinch River due to a below-normal river flow.

Silt monitoring[3] performed during the summer months showed that the gamma count rate in the Clinch River in 1959 increased sharply immediately downstream from the point of entry of the wastes, peaking at Mile 16.3. This is in contrast to the gradual increase shown in previous years with the peaks occurring at about Mile 8. The magnitude of the peak increased from 179 c/s in 1958 to 252 c/s in 1959. The gamma count rate in the Tennessee River showed essentially the same pattern as in previous years. The major radionuclide contained in the river silt was Cs^{137}. In terms of $(MPC)_w$, however, Sr^{90} continued to be the most significant radionuclide.

During the last two months of the year gross beta activity levels leaving White Oak Creek increased by an order of magnitude due primarily to two accidental

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2. Values as recommended by the NCRP.
3. Procedures and techniques described in ORNL-2847, "Radioactivity in Silt of Clinch and Tennessee Rivers", by W. D. Cottrell.

releases of Ru^{106} from Laboratory facilities and seepage from waste pit No. 4. An accidental release of approximately 55 curies of radioactive liquid wastes consisting primarily of Ru^{106} occurred at a chemical processing plant during the last week of October. Again in November, widespread fall-out of Ru^{106} originated from a stack operation. The major portion of these releases was effectively impounded behind White Oak Creek Dam and discharged to the Clinch River at a rate such that levels of radioactivity in the river were maintained below the $(MPC)_w$ for populations in the neighborhood of a controlled area. As the relative hazard of Ru^{106} is low compared to Sr^{90}, the $(MPC)_w$ in the river was not significantly affected. (The maximum permissible concentration for Ru^{106} is a factor of approximately 100 greater than Sr^{90} which figures heavily in the weighted average $(MPC)_w$ calculation.)

The average radiation background in the Laboratory area as based on monthly measurements was 0.13 mr/hr. The average background measured in the perimeter area (out to approximately 10 miles) was .02 mr/hr. These may be compared to the average value established in 1943 of 0.012 mr/hr.

The laundry monitoring unit monitored 423,375 garments during the year. A total of 29,004 garments was found to be above maximum permissible limits. In addition to garments, a total of 702,815 items such as towels, shoe covers, gloves, and caps passed through the monitoring station.

B. Personnel Monitoring

There were no personnel exposures during 1959, as recorded on the personnel meters or from bio-assay analyses, which exceeded the limits recommended in NBS Handbooks 52 and 59. The highest total dose sustained by Laboratory personnel was about 9 rem or 75% of the maximum permissible annual dose of 12 rem. Only ten employees received exposures greater than the maximum permissible yearly average of 5 rem.

As of December 27, 1959, the highest cumulative dose sustained by Laboratory personnel was 69.7 rem. The ten highest cumulative doses ranged downward from the high of 69.7 rem to 47.8 rem.

As of December 27, 1959, only one individual had accumulated a total dose which exceeded the age proration formulas. The major portion of the dose resulted from an accident which occurred during 1957 and, at the end of 1959, represented 193% of the dose permitted by the formula 5(N-18). A total of 11 employees had accumulated a total dose which exceeded 50% of the age proration formulas. (See Part II, Section B for detailed listings.)

C. Assays-Instruments

A total of 404,573 samples were processed through the counting room or an average of 7,780 per week. This is approximately 18% more than was processed last year.

The Bio-Assays Laboratory Group processed a total of 3,223 samples. Approximately 33% of the samples were analyzed for Sr^{90} and approximately 37% were analyzed for gross alpha (Pu).

The fabrication and installation required to permit initial background studies and calibration of the Whole Body Counter neared completion during 1959. The addition to Building 2008 for housing and steel room, the alterations to Building 2008, and the erection of the steel for the steel room were completed. Construction progress was hampered and previously estimated completion dates had to be extended to accommodate the slow delivery of necessary items from outside vendors.

D. Radiation Surveys

Over the past several years considerable discussion has evolved concerning an appropriate definition for the so-called "unusual occurrence" as related to health physics practices. Up until the present time no clear-cut definition has existed and it has been difficult to classify some of these events without being somewhat misleading as to the significance which should be attached to a given situation.

In practice, the unusual occurrence may be classified into two areas of interest. First, there is the major event which because of its severity or unique characteristics has public relations significance or is an item of concern to the atomic energy program in general. Second, there is the minor event which requires attention from a nuisance point of view and results in no more than a minor adjustment in planning and personnel assignments. On the basis of the above definitions, the Laboratory sustained approximately 47 unusual occurrences during 1959 of which only three were classified as major.

The three major events were involved with equipment failure and personnel exposures were maintained below maximum permissible levels. The first event occurred over a period of a few days and resulted in a release of Ru^{106} through process-waste lines to the waste treatment plant. The release stemmed from a leak in the wall of a heat exchanger in a chemical processing plant. The situation was effectively controlled and no significant contamination problem resulted, even though special control measures were necessary to prevent exceeding the $(MPC)_w$ in the Clinch River. The second event occurred in two parts on successive days and resulted in the distribution of radioactive particulates of Ru^{106} over a large portion of the Laboratory area. Both parts of this event were caused by short test operations of a fan at the base of an off-gas stack located in the central part of the Laboratory. The third event resulted from a chemical explosion in a chemical processing plant. Plutonium contamination was dispersed in and around several buildings near the central part of the Laboratory. Operational shutdowns and extensive decontamination efforts were necessitated.

Many important lessons were learned from the three cases cited in the preceding paragraph. Although the Laboratory maintained its good record insofar as personnel exposures were concerned, considerable effort was required for clean-up of contaminated surfaces and the need was indicated for more comprehensive preplanning and detailed emergency procedures to spell out individual responsibilities.

The 44 minor events may be classified as follows:

(1)	Cases involving <u>only</u> the contamination of equipment and/or facilities followed by minor clean-up effort	36
(2)	Cases involving both the contamination of personnel and equipment followed by minor work restrictions and/or clean-up effort	4
(3)	Cases involving <u>only</u> the contamination of personnel and followed by minor work restrictions	4
	Total	44

Two major events occurred within facilities operated by the Chemical Technology Division; one major event occurred within facilities operated by the Operations Division. The 44 minor events were attributed to facilities operated by the following Laboratory divisions:

Analytical Chemistry	2
Biology	1
Chemistry	2
Chemical Technology	12
Engineering and Mechanical	2
Health Physics	1
Isotopes	13
Operations	2
Physics	4
REED	5
Total	44

Of the 47 events, only 14 occurred (or were detected) during the off shifts when the Laboratory population was at its lowest number.

Except for the three major events, the occurrence of these events in 1959 may be considered as typical when compared to the experience in previous years.

II. STATISTICAL RESUME

A. Area Monitoring

B. Personnel Monitoring

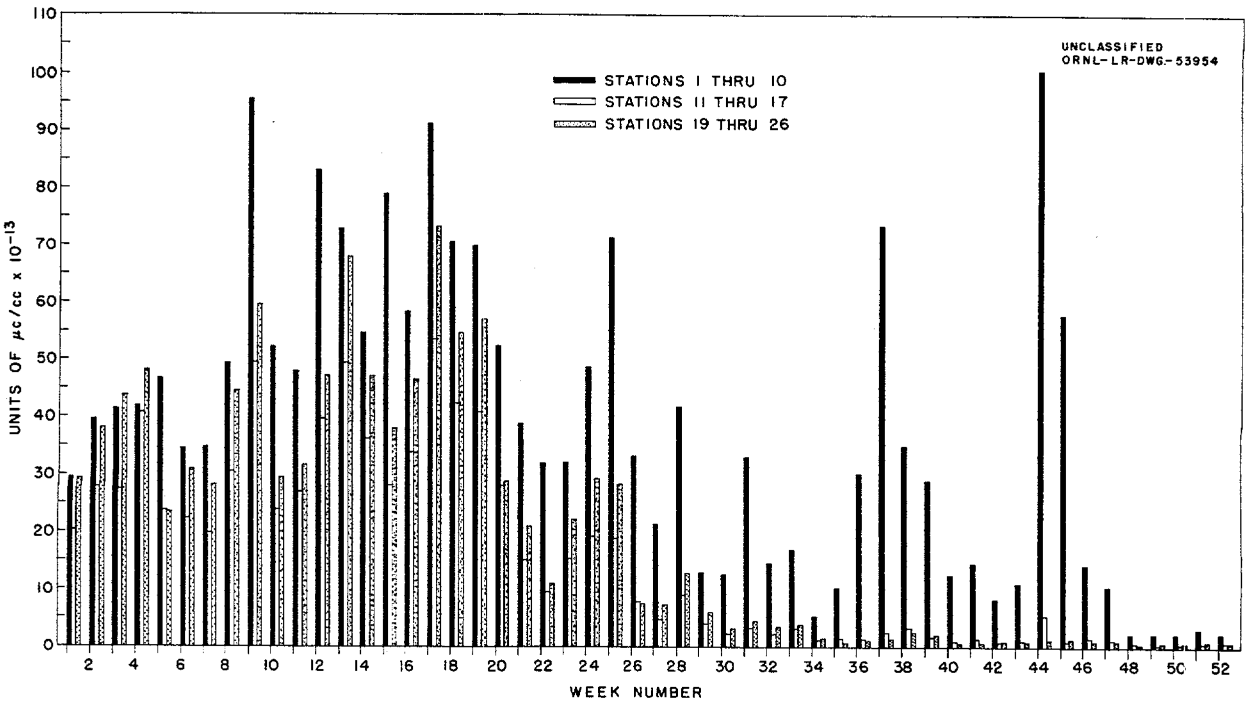

FIG. 1 AIR CONTAMINATION LEVELS IN 1959 AS MEASURED ON THE COLLECTING FILTERS ON THE CONTINUOUS AIR MONITORS

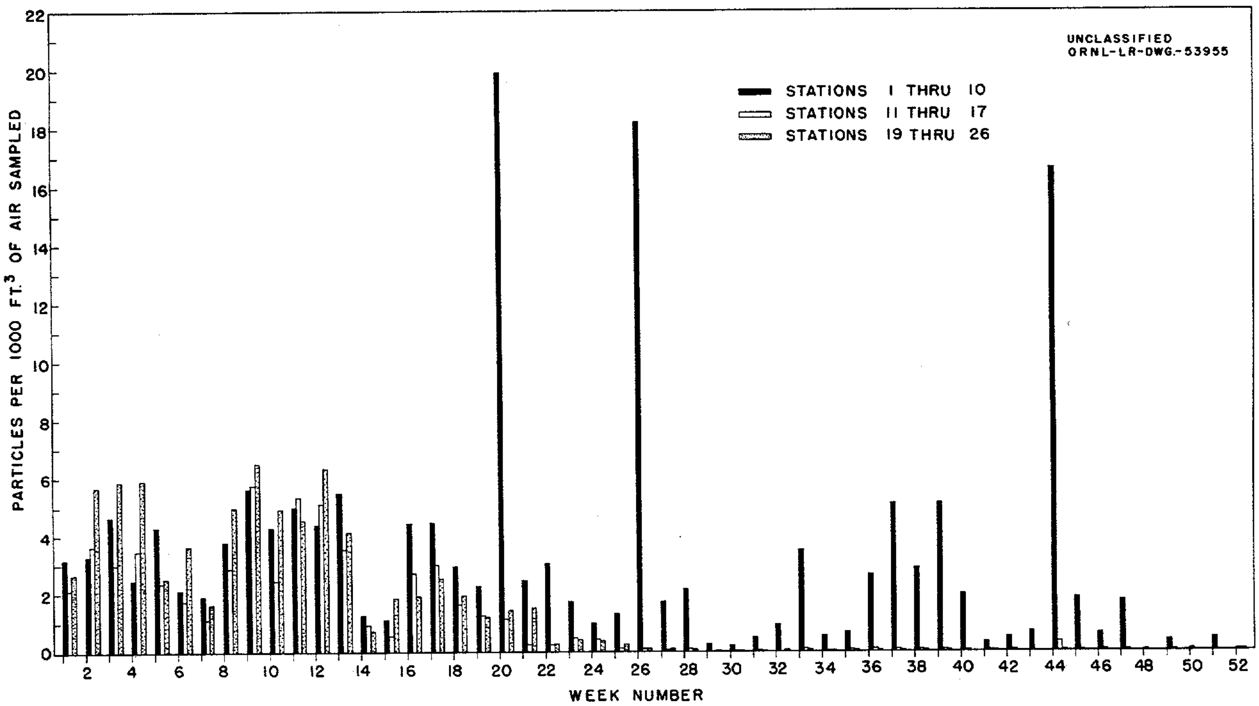

FIG. 2 RADIOPARTICULATE FALL-OUT COLLECTED ON FILTERS BY CONTINUOUS AIR MONITORS

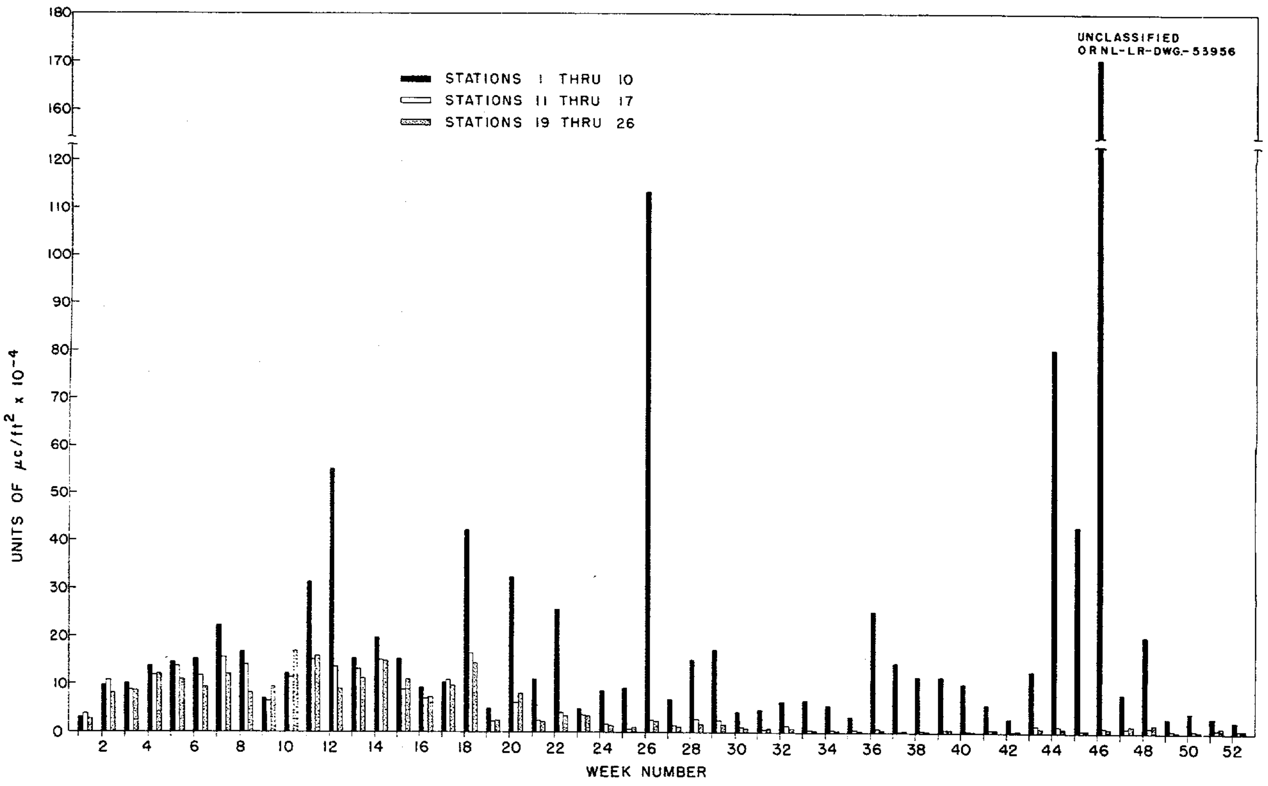

FIG. 3 RADIOACTIVE FALL-OUT IN 1959 AS MEASURED BY THE GUMMED PAPER METHOD

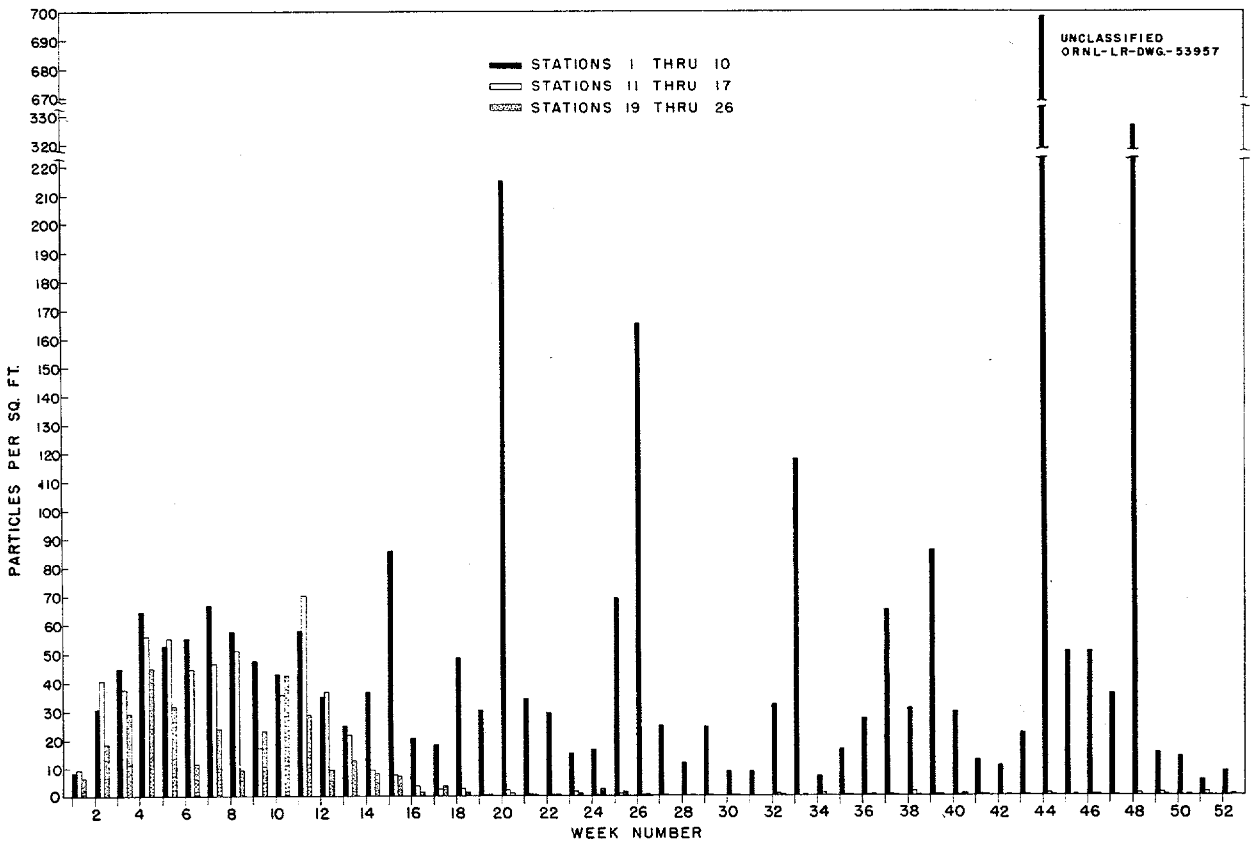

FIG. 4 RADIOPARTICULATE FALL-OUT IN 1959 AS MEASURED BY THE GUMMED PAPER METHOD

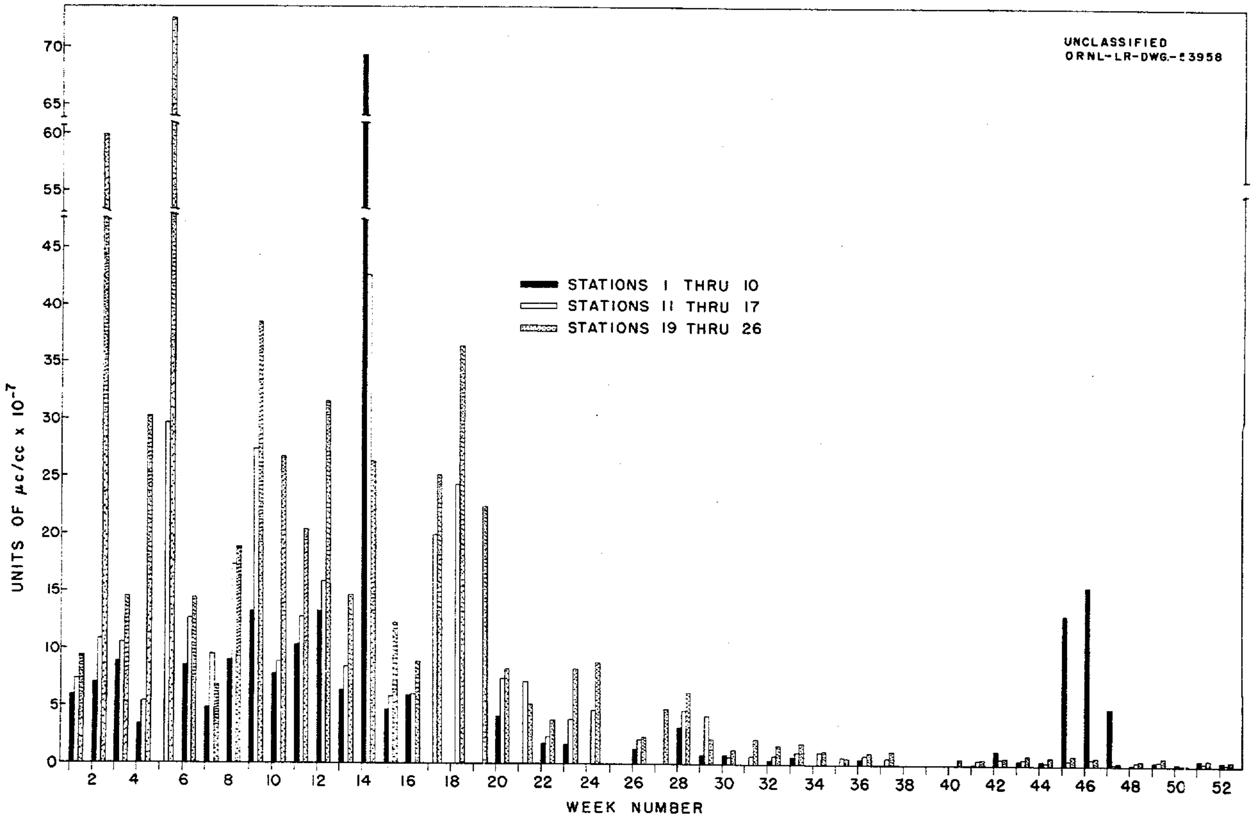

FIG. 5 RADIOACTIVITY IN RAIN WATER IN 1959

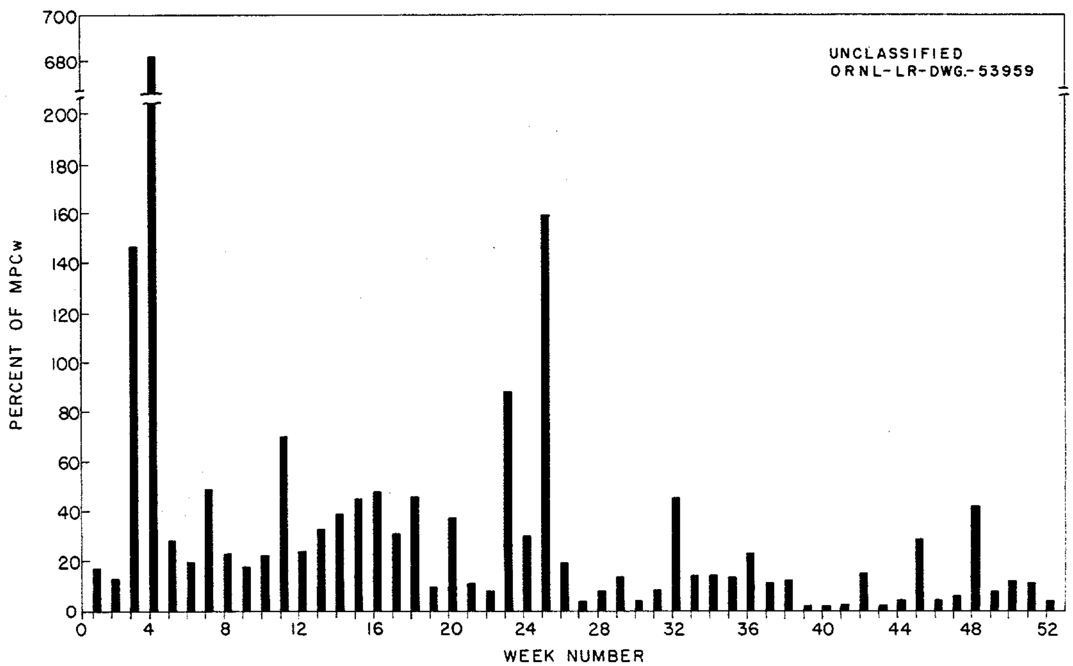

FIG. 6 AVERAGE WEEKLY CONCENTRATION OF RADIONUCLIDES IN THE CLINCH RIVER DURING 1959 AS DETERMINED BY RADIOCHEMICAL ANALYSES

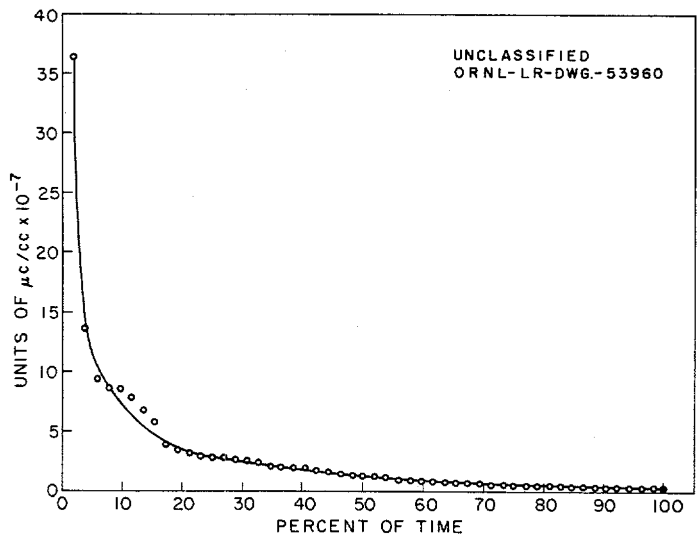

FIG. 7 VARIATIONS IN THE CONCENTRATIONS OF RADIOACTIVITY IN THE CLINCH RIVER, 1959

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ORNL-LR-DWG. 52794

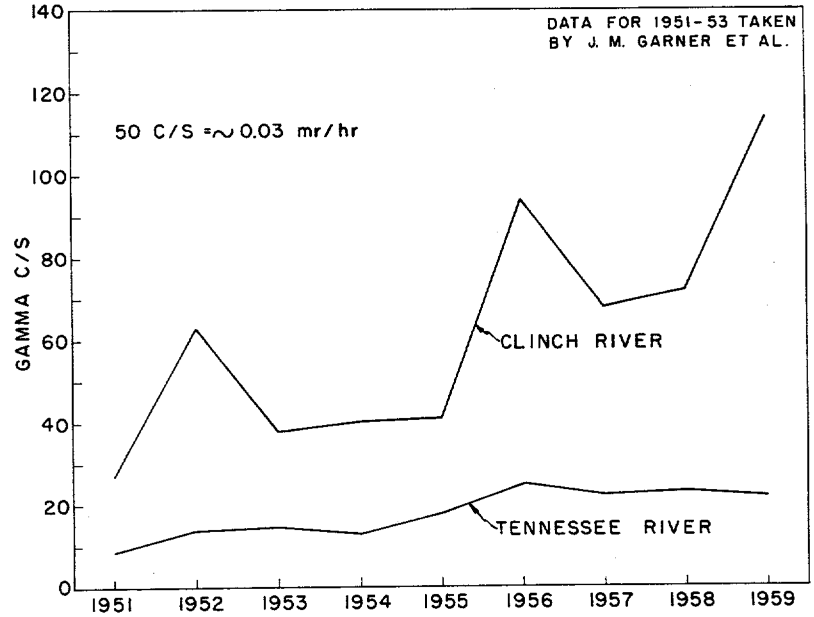

FIG. 8 AVERAGE GAMMA COUNT AT SURFACE OF SILT
CLINCH AND TENNESSEE RIVERS
1951-59

UNCLASSIFIED
ORNL-LR-DWG. 52795

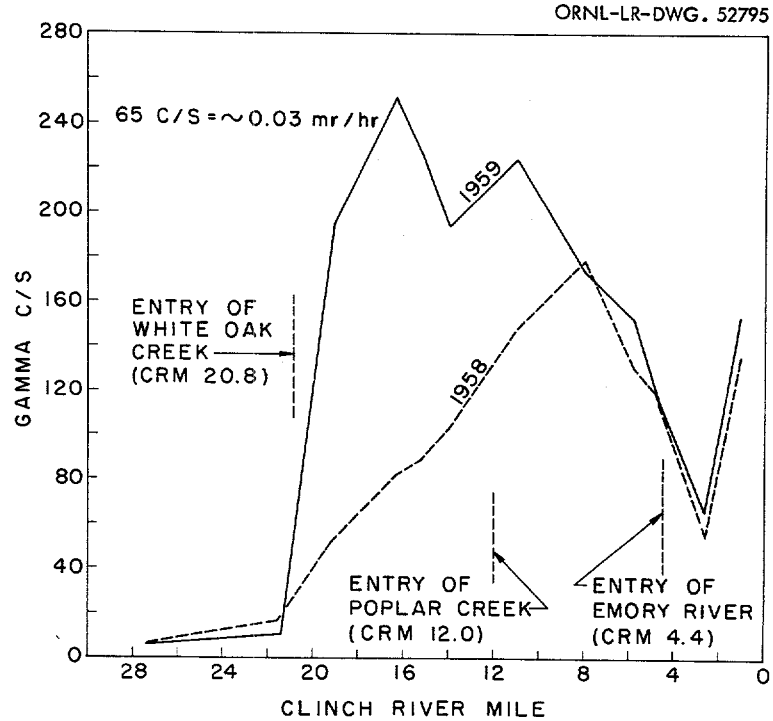

FIG. 9 GAMMA COUNT AT SURFACE OF CLINCH RIVER SILT

UNCLASSIFIED
ORNL-LR-DWG. 52796

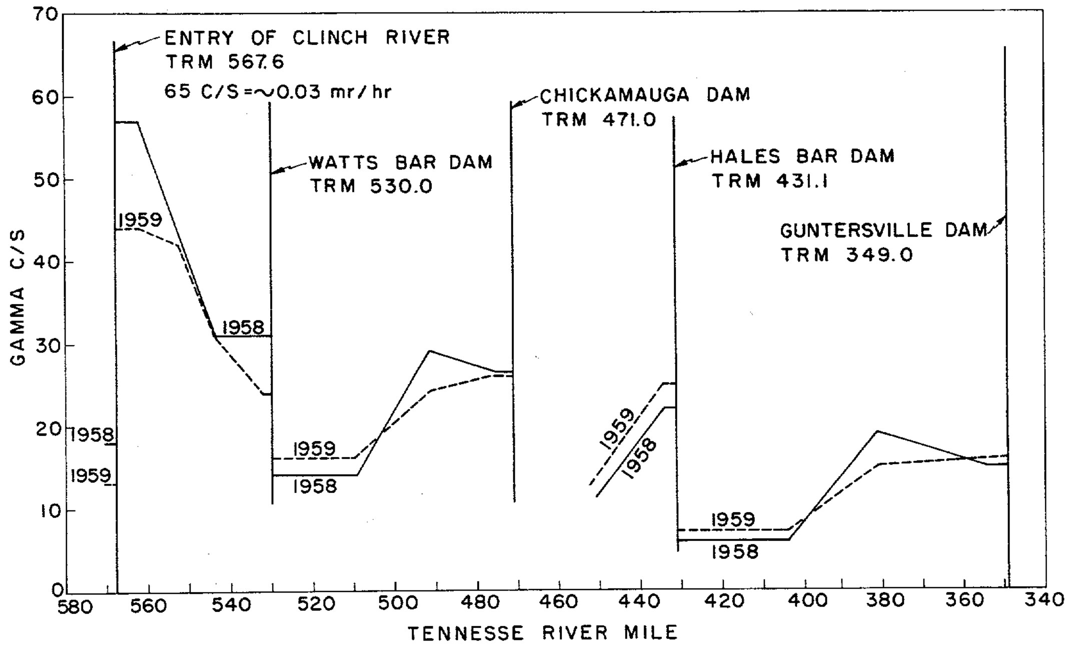

FIG. 10 GAMMA COUNT AT SURFACE OF TENNESSEE RIVER SILT

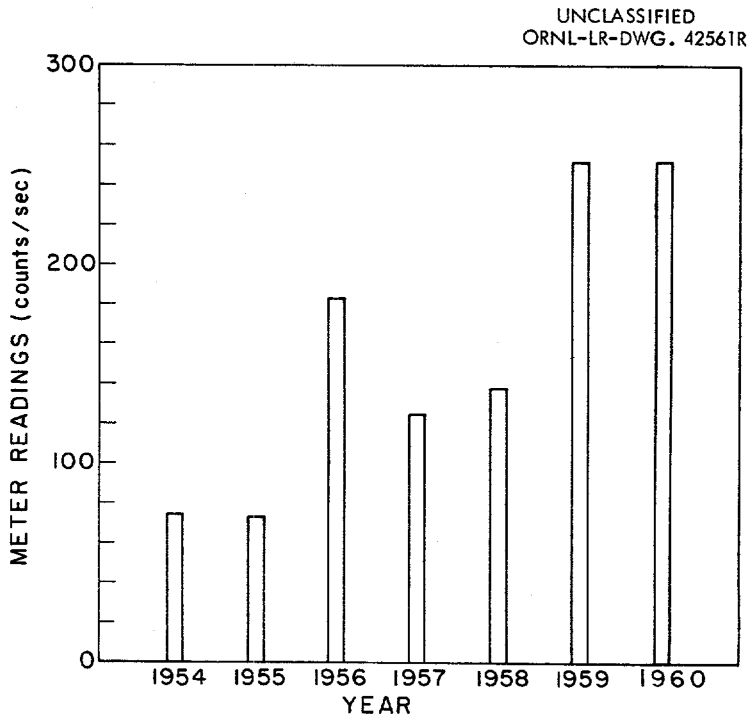

FIG. 11 AVERAGE READING ACROSS THE TRAVERSE AT LOCATION OF MAXIMUM CONTAMINATION

Table 1

AVERAGE CONCENTRATION OF MAJOR RADIOACTIVE CONSTITUENTS

IN THE CLINCH RIVER, 1959

Location	Sampling Period	Radioactivity of Nuclides in Units of 10^{-8} μc/cc					Calculated Av. Concen. of Radioactivity	$(MPC)_w^a$	% of
		Sr^{90}	Ce^{144}	Cs^{137}	$Ru^{103-106}$	Co^{60}	μc/cc x 10^{-8}	10^{-6} μc/cc	MPC
Clinch River									
Mi. 37.5	10/1/59 - 1/29/60	0.11	0.10	*	*	*	0.45	0.21	2.14
Mi. 20.8[b]	12/28/58 - 12/27/59	2.00	1.5	1.9	7.4	1.8	31.0	1.22	25.4
Mi. 4.5	10/23/58 - 11/3/59	1.86	0.54	0.53	1.14	0.23	4.9	0.22	22.3

a. Weighted average $(MPC)_w$ calculated for the mixture using $(MPC)_w$ values for specific radionuclides recommended in the NBS Handbook 69.

b. Values given for this location are calculated values based on the levels of waste released and the dilution afforded by the river.

* None detected.

Table 2

RADIONUCLIDES IN RIVER SILT - 1959

UNITS OF 10^{-6} $\mu c/g$ OF DRIED MUD

Sample Location		Cs (as $Cs-Ba^{137}$)	Ce (as $Ce-Pr^{144}$)	Sr (as Sr^{90})	Co (as Co^{60})	Ru (as $Ru-Rh^{106}$)	Nb (as Nb^{95})	Zr (as Zr^{95})	TRE*
Clinch R. M	21.5	4.5	6.8	0.5	0.9	4.5	2.7	1.8	5.3
	19.1	527.0	92.3	9.5	69.4	18.0	3.2	1.8	251.1
	16.3	464.0	70.7	9.0	53.2	16.7	2.3	1.8	151.5
	15.2	391.0	54.1	7.2	41.0	18.0	2.3	1.4	141.9
	14.0	464.0	65.3	8.6	52.7	17.1	3.2	1.8	148.8
	11.0	228.8	27.0	5.4	26.1	9.9	3.2	3.2	57.8
	8.0	236.5	29.7	5.9	27.9	11.3	3.6	2.7	71.3
	5.8	207.2	20.3	4.5	29.3	7.7	2.7	2.7	56.5
	4.7	168.9	17.6	4.5	25.7	7.2	3.6	3.6	32.9
	2.6	171.2	9.0	1.4	18.5	6.3	2.3	0.9	19.3
	1.1	258.6	20.3	2.7	20.0	9.9	2.3	0.9	40.3
Av.		283.8	37.5	5.4	33.2	11.5	2.9	2.1	88.8
Tenn. R. M	570.8	1.8	2.3	0.5	0.9	3.6	2.7	1.4	1.7
	562.7	40.5	7.7	0.9	6.8	6.3	3.6	1.8	8.5
	552.7	40.5	5.0	1.4	8.1	5.0	2.7	0.9	7.1
	543.8	23.4	2.7	0.9	5.0	3.6	2.7	0.9	5.3
	532.0	25.7	5.4	1.4	3.6	3.1	4.5	0.9	6.7
	509.9	6.8	**	0.5	**	**	**	**	8.0
	491.9	13.5	3.2	0.9	3.6	3.6	3.2	1.8	2.9
	475.1	10.8	4.5	0.9	2.7	5.4	2.7	1.4	5.6
	434.1	12.6	9.0	0.9	2.7	8.6	3.6	0.9	7.1
	381.2	3.2	1.8	0.5	1.4	2.7	2.7	0.9	0.2
	354.4	3.6	3.6	0.5	1.8	4.1	3.6	0.9	2.5
Av.		16.6	4.5	0.8	3.7	4.6	3.2	1.1	5.1

* Tl^{204} was used as a reference standard for tri-valent rare earth fraction.

** Insufficient sample for complete analyses.

Table 3

AVERAGE WEEKLY AIR CONTAMINATION DATA BY STATIONS, 1959

Station Number	Location	Long-Lived Activity μc/cc	No. of Particles by Activity Ranges[a] $< 10^5$ d/24hr	10^5-10^6 d/24hr	10^6-10^7 d/24hr	$> 10^7$ d/24hr	Total	Particles Per 1000 ft^3
			Laboratory Area					
HP-1	S 3587	20.48×10^{-13}	86.56	1.62	0.15	0.02	88.35	1.59
HP-2	S 3001	31.35	82.57	3.06	0.38	0.04	86.06	1.71
HP-3	S 1000	26.58	74.90	1.69	0.23	0.00	76.83	0.98
HP-4	W 3513	56.09	353.98	1.71	0.12	0.06	355.87	7.85
HP-5	E 2506	119.32	497.75	3.06	0.19	0.00	501.00	11.43
HP-6	SE 3012	29.72	118.90	2.31	0.22	0.06	121.49	1.75
HP-7	W 7001	20.76	87.83	0.98	0.12	0.00	88.92	1.45
HP-8	Rock Quarry	21.12	66.52	1.19	0.12	0.00	67.83	1.11
HP-9	N Bethel Valley Rd.	29.30	91.02	1.27	0.02	0.00	92.31	1.54
HP-10	E 2074	31.53	119.87	1.21	0.02	0.00	121.10	2.81
Average		38.62×10^{-13}						3.22
			Perimeter Area					
HP-11	Kerr Hollow Gate	15.77×10^{-13}	58.67	0.71	0.04	0.00	59.42	1.20
HP-12	Midway Gate	16.29	63.57	0.55	0.00	0.00	64.12	1.29
HP-13	Gallaher Gate	16.63	46.69	0.88	0.06	0.00	47.63	0.95
HP-14	White Wing Gate	11.30	40.50	0.54	0.06	0.00	41.10	0.82
HP-15	Blair Gate	19.97	68.29	0.76	0.02	0.00	69.08	1.52
HP-16	Turnpike Gate	13.48	42.63	0.44	0.06	0.00	43.13	0.86
HP-17	Hickory Creek Bend	16.86	50.15	0.81	0.00	0.00	50.96	1.02
Average		15.76×10^{-13}						1.09
			Remote Area					
HP-19	Norris Dam	23.23×10^{-13}	89.19	1.44	0.08	0.00	90.71	1.64
HP-20	Loudoun Dam	22.11	77.96	1.31	0.06	0.00	79.35	1.43
HP-21	Douglas Dam	10.91	15.68	0.00	0.00	0.00	15.68	0.28
HP-22	Cherokee Dam	16.01	29.77	0.00	0.00	0.00	29.77	0.54
HP-23	Watts Bar Dam	5.13	2.62	0.00	0.00	0.00	2.62	0.05
HP-24	Great Falls Dam	2.53	0.96	0.00	0.00	0.00	0.96	0.02
HP-25	Dale Hollow Dam	18.04	57.50	0.33	0.00	0.00	57.83	1.01
HP-26	Berea, Kentucky	13.77	52.57	0.59	0.00	0.00	53.16	1.10
Average		13.97×10^{-13}						0.76

a. Determined by continuous air monitor.

Table 4

AVERAGE WEEKLY FALLOUT DATA BY STATIONS, 1959

Station Number	Location	Long-Lived Activity $\mu c/ft^2$	No. of Particles by Activity Range[a] $< 10^5$ d/24 hr	10^5-10^6 d/24 hr	10^6-10^7 d/24 hr	$> 10^7$ d/24 hr	Total Particles Per Sq.Ft.
		Laboratory Area					
		$\times 10^{-4}$					
HP-1	S 3587	9.82	26.71	2.46	0.42	0.06	29.65
HP-2	S 3001	45.36	105.31	6.67	4.38	1.21	117.56
HP-3	S 1000	6.57	13.04	0.54	0.19	0.02	13.79
HP-4	W 3513	20.29	204.23	1.33	0.27	0.00	205.83
HP-5	E 2506	22.51	103.75	2.58	0.54	0.10	106.96
HP-6	SE 3012	61.23	49.79	6.65	3.88	0.94	61.27
HP-7	W 7001	6.09	15.52	1.04	0.27	0.00	16.83
HP-8	Rock Quarry	4.85	8.90	0.17	0.06	0.00	9.13
HP-9	N Bethel Valley Rd.	5.86	9.44	0.29	0.17	0.04	9.94
HP-10	E 2074	19.77	29.04	3.62	1.98	0.33	34.96
Average		20.24×10^{-4}					60.59
		Perimeter Area					
		$\times 10^{-4}$					
HP-11	Kerr Hollow Gate	5.01	11.77	0.19	0.00	0.00	11.96
HP-12	Midway Gate	5.01	12.62	0.23	0.00	0.00	12.85
HP-13	Gallaher Gate	4.63	10.29	0.19	0.02	0.00	10.50
HP-14	White Wing Gate	4.86	9.90	0.21	0.02	0.00	10.13
HP-15	Blair Gate	5.37	11.98	0.15	0.00	0.00	12.15
HP-16	Turnpike Gate	5.03	9.31	0.13	0.06	0.00	9.50
HP-17	Hickory Creek Bend	4.41	9.38	0.08	0.04	0.00	9.50
Average		4.90×10^{-4}					10.94
		Remote Area					
		$\times 10^{-4}$					
HP-19	Norris Dam	4.36	5.87	0.33	0.04	0.00	6.23
HP-20	Loudoun Dam	4.17	5.12	0.16	0.00	0.00	5.27
HP-21	Douglas Dam	1.99	0.51	0.00	0.00	0.00	0.51
HP-22	Cherokee Dam	2.51	0.90	0.00	0.00	0.00	0.90
HP-23	Watts Bar Dam	0.71	0.34	0.00	0.03	0.03	0.41
HP-24	Great Falls Dam	0.63	0.19	0.00	0.00	0.00	0.19
HP-25	Dale Hollow Dam	4.26	4.48	0.04	0.02	0.00	4.54
HP-26	Berea, Kentucky	4.88	7.00	0.19	0.00	0.00	7.19
Average		2.94×10^{-4}					3.16

a. Determined by gummed paper fall-out trays.

Table 5

AVERAGE WEEKLY RAINOUT DATA BY STATIONS, 1959

Station Number	Location	Activity in Collected Rain Water, μc/cc
	Laboratory Area	
HP-7	W 7001	6.26×10^{-7}
	Perimeter Area	
HP-11	Kerr Hollow Gate	7.22×10^{-7}
HP-12	Midway Gate	6.30
HP-13	Gallaher Gate	6.10
HP-14	White Wing Gate	6.53
HP-15	Blair Gate	5.78
HP-16	Turnpike Gate	8.82
HP-17	Hickory Creek Bend	8.14
Average		6.98×10^{-7}
	Remote Area	
HP-19	Norris Dam	11.26×10^{-7}
HP-20	Loudoun Dam	14.65
HP-21	Douglas Dam	3.86
HP-22	Cherokee Dam	4.41
HP-23	Watts Bar Dam	1.32
HP-24	Great Falls Dam	1.41
HP-25	Dale Hollow Dam	8.02
HP-26	Berea, Kentucky	10.14
Average		6.88×10^{-7}

Note: Total rainfall in 1959 was 49.02 inches, a deviation of -6.4% from the normal rainfall of 52.38 inches.

Table 6

AVERAGE WEEKLY LIQUID WASTE DISCHARGE, 1959

Measurements	Settling Basin		White Oak Creek Dam	
	Year 1959	% Deviation From 1958 Weekly Average	Year 1959	% Deviation From 1958 Weekly Average
Beta Curies Discharges	3.49	+ 98.3	18.02	+72.3
Submersion Data				
Beta (mrep/hr)	0.270	+114.0	0.054	- 1.8
Gamma (mr/hr)	0.181	+ 82.0	0.044	+57.1
Total (mrad/hr)	0.451	+ 76.9	0.099	+17.9
Pu and other transuranic Alpha Emitters discharged				
(μg/cc)	1.1×10^{-5}	+2630.0	1.5×10^{-6}	+444.4
(mg)	223.154	+3313.1	211.024	+796.4

Note: The probable average concentration in the Clinch River below White Oak Creek is calculated to be 3.08×10^{-7} μc/cc, using as a dilution factor the ratio of White Oak Creek discharge to the flow of Clinch River.

This is 126% greater than the 1958 weekly average.

Table 7

TOTAL SAMPLES PROCESSED BY THE ANALYTICAL UNITS, 1959

	Continuous Air Monitor Filters		Fallout Tray Gummed Paper		Rain Water Samples		Liquid-Effluent Samples			
	Total No.	Average Weekly	Total No.	Average Weekly	Total No.	Average Weekly	Gross Beta	Total Gamma Submersion	Pu	Prepared for Radiochemical Analyses
Local Stations	527	10.1	540	10.4	74	1.4				
Perimeter Stations	362	6.7	364	7.0	604	11.6				
Remote Stations	329	6.3	320	6.2	576	11.1				
Building CAM's	5930									
Stack Monitors	549									
Special	2400	46.2	448	9.4						
Settling Basin							1080	258	104	12
White Oak Creek							768			
Melton Branch							764			
White Oak Dam							1141	357	104	12
Clinch River							6			

Table 8 Pertinent Data Regarding the Ten Laboratory Employees Who Have Sustained the Highest Cumulative Dose of Penetrating Radiation as of December 27, 1959.

Employee	Department or Division	Age (yrs.)	Tenure of Employment (yrs.)	Penetrating Radiation Dose (rem)
A	Isotopes	40	15	69.7
B	E and M	25	7	67.5
C	Isotopes	41	12	62.9
D	Isotopes	35	16	59.9
E	Isotopes	53	15	58.7
F	Isotopes	52	14	56.5
G	Isotopes	34	13	52.0
H	Isotopes	40	8	49.4
I	Isotopes	28	8	49.2
J	Isotopes	32	9	47.8

Table 9 Pertinent Data Regarding the Ten Laboratory Employees Who Have Sustained the Highest Exposure as Based on the Age Formula 5(N-18). (Note: Employees A, B, C, D, G, I, and J are also listed in Table 8.)

Employee	Department or Division	Age (yrs.)	Tenure of Employment (yrs.)	Percent MPAD 5(N-18)
B	E and M	25	7	193
I	Isotopes	28	8	98
K	Isotopes	29	10	73
D	Isotopes	35	16	70
J	Isotopes	32	9	68
L	Isotopes	31	7	68
G	Isotopes	34	13	65
A	Isotopes	40	15	63
M	I and C	29	8	63
C	Isotopes	41	12	55

Table 10 Dose Data Summary for Laboratory Population Involving Exposure to Penetrating Radiation During 1959.

Dose Range (rem)	Number of Employees	Percentage of Population
1 or less	4254	90.61
2 or less	4516	96.19
3 or less	4621	98.43
4 or less	4660	99.25
5 or less	4685	99.79
6 or less	4688	99.85
7 or less	4693	99.96
8 or less	4694	99.98
9 or less	4695	100.00

Table 11 Dose Data Summary for Laboratory Population as of December 27, 1959, Involving Cumulative Exposure to Penetrating Radiation as Based on the Age Proration Formula 5(N-18).

Dose Range % 5(N-18)	Number of Employees	Percentage of Population
10 or less	4407	93.72
20 or less	4581	97.57
30 or less	4652	98.08
40 or less	4677	99.62
50 or less	4684	99.77
60 or less	4686	99.81
70 or less	4691	99.91
80 or less	4693	99.96
90 or less	4693	99.96
100 or less	4694	99.98
193 or less	4695	100.00

Table 12

PERSONNEL METER DISTRIBUTION AND PERFORMANCE DATA

a. Pocket Meters

(1) Meters distributed	287,707
(2) Readable meters	287,537
(3) Non-readable meters	170
(4) Non-readable pairs	0
(5) Off-scale readings	1,088
(6) Off-scale pairs	54

b. Film Meters

(1) Distribution and processing data

(a) Film badge meters (routine)	23,101
(b) Film badge meters (non-routine)	169
(c) Film meters (paper)	32,905
(d) Rings, Packets, etc.	6,389
(e) Neutron film (routine)	24,034
(f) Neutron film (special)	1,119
(g) Other Installations	5,048
(h) Calibrations	4,355
(i) Total films handled	97,120

(2) Reasons for non-routine processes

(a) Special requests	106
(b) Security (name change, etc.)	4
(c) Pocket meter total 1500 mr	5
(d) Off-scale pocket meters	54
(e) Total	169

(3) Data Loss

(a) Film damaged (complete data loss)	53
(b) Film damaged (partial data loss)	3
(c) Light, X-rays, etc. (complete data loss)	18
(d) Light, X-rays, etc. (partial data loss)	12
(e) Badge meters not serviced	59
(f) Films lost	35
(g) Total	180

Table 13

COUNTING SERVICES PERFORMED, 1959

Type of Sample	Calculations	Number of Samples Alpha	Number of Samples Beta	Total	Weekly Average
Smears		162,508	178,105	340,613	6,550.2
Air Samples	19,528	17,687	16,993	54,207	1,042.4
Area Monitoring		393	4,634	5,027	96.6
Sanitary Engineering		458	1,201	1,659	31.9
Decay and Absorption	393	10	2,664	3,067	59.0
TOTAL	19,921	181,056	203,597	404,573	7,780.1

Table 14

BIO-ASSAYS ANALYSES, 1959

Determinations	Number of Samples Received	Weekly Av.	Highest Specimen Analyzed
H^3	34	.65	150 µc/liter
Gα (Fecal)	361	6.94	1.2×10^3 d/m/24 hrs.
Gα (Urine)	821	15.79	2.48 d/m/24 hrs.
Cs	57	1.10	4.4×10^3 d/m/24 hrs.
P^{32}	12	.23	6.5×10^5 d/m/24 hrs.
Ra	140	2.69	.83 d/m/24 hrs.
R.E. (Total Rare Earths)	53	1.02	3.0×10^4 d/m/24 hrs.
Sr	1056	20.31	3.2×10^4 d/m/24 hrs.
U	789	15.17	93 d/m/24 hrs.

Table 15

INSTRUMENTS ACQUIRED, 1959

Instrument Type	Quantity	Unit Cost	Total Cost
A. C. Poppy, Scintillation, Q 1957	6	$ 1000	$ 6000
Background Monitor, Q 1951	3	1000	3000
200 Channel Analyzer	1	20,000	20,000
Alpha Counter, SAC	6	1400	8400
Low Background Beta Counter	1	7000	7000
Radiation Monitor, Q 1916	1	1000	1000
Alpha Counter, MAC	1	5500	5500
Scintillation Counter, 3 x 3 NaI, Well	1	2200	2200
Thermal Neutron Survey Meter	1	1500	1500
Alpha Air Monitor	2	3000	6000
Plutonium Probe	1	1500	1500
Hand-Foot Monitor	12	2500	30,000
Alpha Floor Monitor	1	1300	1300
Minometer, Mod. 687	1	250	250
Portable Scaler, NICC 2800	1	1350	1350
Continuous Air Monitor, B. G.	1	3700	3700

Table 16

PORTABLE INSTRUMENTS ON ASSIGNMENT TO FIELD AREAS BY BUILDING NUMBER, 1959

Type	3001	3019	3026	3038	3505	3550	4500	7500	3517	9771	Total
Cutie Pie	58	28	19	41	12	27	58	23	14	14	294
Juno	8	1	3	1	0	2	11	2	0	4	32
GMSM	35	17	16	26	4	23	43	9	5	18	196
Samson	0	5	0	0	6	2	12	0	0	14	39
Dosimeter	11	31	13	16	28	15	35	5	18	32	204
PSA	2	0	1	1	0	2	6	0	0	1	13
Misc.	18	8	4	11	1	2	16	10	3	8	81
Total	132	90	56	96	51	73	181	49	40	91	859

Table 17

CALIBRATIONS RESUME, 1959

Type Instrument	Total No. of Calibrations
Cutie Pie	1736
Juno	108
Samson	168
G M Survey Meter	1050
Dosimeters	264
Portable Scintillation, Alpha	68
Monitrons	176
Minometers	10
Films	9784
Miscellaneous	378
Total	13,742

III. REPORTS AND PAPERS

A. Central Files Reports

E. D. Gupton, D. M. Davis, J. C. Hart, "Criticality Accident Application of the ORNL Badge Dosimeter", ORNL-CF-59-40-41, October 14, 1959.

W. D. Cottrell, "Radioactivity in Silt of the Clinch and Tennessee Rivers", ORNL-2847, November, 1959.

B. Papers

H. H. Abee, D. M. Davis, "Radioactive Background Levels in the East Tennessee Area"; presented at the Health Physics Division Annual Information Meeting, October, 1959.

H. H. Abee, W. D. Cottrell, "Contamination Resulting from the Release of Radioactive Liquid Waste to the Tennessee River System"; presented at the AIHA Conference, Chicago, Illinois, April, 1959.

E. D. Gupton, P. E. Brown, "The ORNL Human Body Counter"; presented at the Health Physics Division Annual Information Meeting, October, 1959.

H. H. Abee, J. C. Hart, "A Proportional Liquid Effluent Sampler for Large Volume Flows"; presented at the Health Physics Division Annual Information Meeting, October, 1959.

C. Interdepartmental Reports

1. Weekly:

    (a) Radioactivity in Clinch River at ORGDP Water Filtration Plant - Area Monitoring Section.

2. Monthly:

    (a) Summary of Bio-Assays Analysis - Assays-Instruments Section.

    (b) Radiochemical Analyses in White Oak Lake - Area Monitoring Section.

    (c) Area Background Check - Area Monitoring Section.

3. Quarterly:

   (a) Summary of Personnel Monitoring Data - Personnel Monitoring Section.

   (b) Environmental Levels of Radioactivity from the Oak Ridge Area - Area Monitoring Section.

   (c) Fall-out Data from ORNL Remote Monitoring Stations - Area Monitoring Section.

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